NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2, 2004

Chemistry

Describe the nature of structure and bonding in different substances (90308)

Describe the structural formulae and reactions of compounds containing selected organic functional groups (90309)

Describe principles of chemical reactivity (90310)

Describe oxidation-reduction reactions (90311)

National Statistics

Assessment Report

Assessment Schedule

Chemistry, Level 2, 2004

General Comments

Candidates gaining Achievement had knowledge of the subject terminology, and were able to use this to identify and *describe* aspects of the chemistry involved. They had knowledge based on the explanatory notes of the achievement standards and were able to use this to answer questions.

Candidates gaining Achievement were able to use correct symbolism for a variety of aspects, such as Lewis structures, equilibrium constant expressions and structures of organic compounds.

Candidates gaining Achievement with Merit or Achievement with Excellence were able to use their knowledge by *applying* it to less familiar contexts, and were able to *discuss* the chemical principles involved clearly and fully. Subject terminology was used correctly and the candidates were able to interpret and use information provided in questions.

Chemistry: Describe the nature of structure and bonding in different substances (90308)

National Statistics

Number of Results	Percentage			
	Not Achieved	Achieved	Merit	Excellence
10,456	42.2%	39.2%	15.6%	3.0%

Assessment Report

Candidates gaining Achievement were able to *draw* simple Lewis structures and *identify* the shapes of molecules. They were able to *identify* the constituent particles in different types of solids and *describe* the attractive forces (bonding) between these particles. They were able to distinguish between intra- and inter-attractive forces. These candidates were able to *describe* a trend in melting points, with reference to the periodic table.

Candidates who gained Achievement with Merit or Achievement with Excellence, were able to *link* the shape of a molecule, and existence of polar bonds, to the polarity of the molecule, as well as explain bond polarity with reference to differing electronegativities of elements. They were able to *discuss* fully, with clear explanations, the structure and bonding in different types of solids and how this *related* to the properties stated. These candidates showed a depth of knowledge and understanding, and were able to express their ideas clearly.

One common misconception was that covalent network solids are made up of molecules, rather than correctly identifying atoms as the particles involved. The term 'electronegativity' was not well understood by many candidates.

Chemistry: Describe the structural formulae and reactions of compounds containing selected organic functional groups (90309)

National Statistics

Number of Results	Percentage			
	Not Achieved	Achieved	Merit	Excellence
10,399	43.6%	26.8%	24.8%	4.7%

Assessment Report

Candidates gaining Achievement were able to *describe structures* of organic compounds by writing IUPAC *names* and by *drawing* structural formulae. They used knowledge to *identify* functional groups and *describe reactions* of these by writing expected observations for chemical tests, as well as structural formulae for reaction products. They were able to *classify* alcohols and *identify* structural and geometric (*cis–trans*) isomers. They understood the use of structural formulae, clearly showing the bonding within the molecule, rather than attempting to use molecular formulae.

Candidates who gained Achievement with Merit or Achievement with Excellence were able to present evidence to *link* appropriate chemical tests to functional groups in order to distinguish between compounds. The tests were described fully and expected observations were *compared* to allow the distinctions to be made. An understanding of both physical and chemical properties of organic compounds was *linked* to the molecular structures. These candidates were able to clearly explain the existence of *cis–trans* isomers and understood addition reactions to asymmetric alkenes. They were able to follow a reaction scheme *linking* a number of different functional groups.

Candidates would have found the assessment specifications to be a very helpful resource as they gave examples of acceptable methods of naming and drawing structural formulae for organic compounds.

Chemistry: Describe principles of chemical reactivity (90310)

National Statistics

Number of Results	Percentage			
	Not Achieved	Achieved	Merit	Excellence
10,174	32.4%	22.6%	31.9%	13.1%

Assessment Report

Candidates gaining Achievement showed a good understanding of the subject terminology and were able to *describe* and use information. They could complete one-step calculations, write equilibrium constant expressions, correctly classify exothermic and endothermic reactions, *identify* the effect of factors on reaction rate and had knowledge of the relationship between hydrogen ion concentration and pH.

Candidates who gained Achievement with Merit or Achievement with Excellence, were able to provide structured and logical answers, which included full information *relating* to the principles involved. For example, correct use of activation energy when discussing the effect of temperature change on reaction

rate. It needs to be clearly understood that it is the energy of the particles that is changed and not the activation energy for the reaction.

Equilibrium principles were *discussed* fully without the confusion of left and right of the reaction. They were able to interpret information provided in questions. These candidates also understood the appropriate use of significant figures in calculations.

Candidates must recognise and use the accepted symbols used in chemistry, such as square brackets to represent concentrations when writing equilibrium constant expressions.

Chemistry: Describe oxidation-reduction reactions (90311)

National Statistics

Number of Results	Percentage			
	Not Achieved	Achieved	Merit	Excellence
10,255	34.5%	23.6%	29.8%	12.1%

Assessment Report

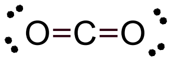
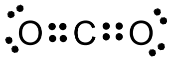
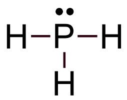
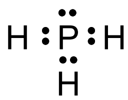
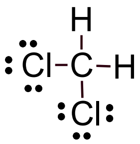
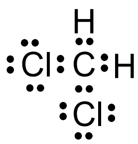
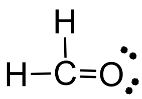
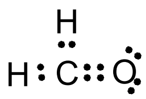
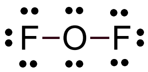
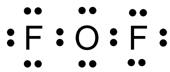
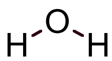
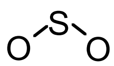
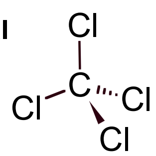
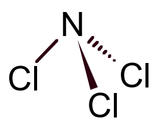
Candidates gaining Achievement, showed a good understanding of the subject terminology. They were able to *describe* oxidation-reduction reactions by *identifying* equations as oxidation or reduction and determining oxidation numbers. They could balance simple half-equations using correct formulae. These candidates could use knowledge of expected observations for reactions involving colour changes appropriately. Knowledge of principles of electrolysis was limited to simple ideas such as ion movement.

Candidates who gained Achievement with Merit or Achievement with Excellence, were able to *discuss* processes by *interpreting* and *relating* given information to the principles involved. They were able to write correctly balanced equations for oxidation-reduction reactions and could *apply* knowledge, such as oxidation numbers and physical properties, to identify products or species present. The principles involved in electrolysis were well-understood by these candidates.

Assessment Schedule

Chemistry: Describe the nature of structure and bonding in different substances (90308)

Evidence Statement

Question	Evidence		Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1	 or   or   or   or   or 		Any **3** structures correct.	All **5** structures correct showing electrons clearly as pairs. Evidence of understanding of non–bonding pairs of electrons and multiple bonds.	
2(a) & 2(b)	(a)	(b)	Any **3** shapes identified correctly by **naming** the shape.	Any **3** shapes identified correctly by naming the shape AND drawing a diagram that accurately depicts the shape (in 3-D) AND 3 matching polarities correct **[3 complete rows correct]**	
	bent / V–shape/ angular 	polar			
	bent / V–shape/ angular 	polar			
	tetrahedral 	non–polar			
	 **trigonal**/triangular **pyramid**	polar			

<table>
<tr><th>Question</th><th colspan="4">Evidence</th><th>Evidence contributing to Achievement</th><th>Evidence contributing to Achievement with Merit</th><th>Evidence contributing to Achievement with Excellence</th></tr>
<tr><td>2(c)(i)</td><td colspan="4">The C–Cl bond in CCl_4 is polar due to the difference in electronegativity of Cl and C. However, the tetrahedral arrangement of the four C–Cl bonds around the C atom is symmetrical so that the effect of these polar bonds is cancelled, making the molecule non–polar.</td><td>Describes 1 factor contributing to the overall non-polarity of CCl_4 molecule.</td><td>Limited discussion – eg refers to symmetry of bond arrangement, polar bonds cancel, but no explanation of polar bonds.</td><td>CCl_4 has been identified as non–polar.
Full discussion – includes difference in electronegativity, polar bonds, symmetry of bond arrangement.</td></tr>
<tr><td>2(c)(ii)</td><td colspan="4">The N–Cl bond in NCl_3 is polar due to the difference in electronegativity of Cl and N. The trigonal pyramid arrangement of the three N–Cl bonds around the N atom is asymmetrical. The lone pair of electrons on the N causes the asymmetry. The effect of the polar bonds is not cancelled, making the molecule polar.</td><td>Describes 1 factor contributing to the overall polarity of NCl_3 molecule.</td><td>Limited discussion – eg refers to asymmetry of bond arrangement, polar bonds do not cancel, but no explanation of polar bonds.</td><td>NCl_3 has been identified as polar.
Full discussion – includes difference in electronegativity, polar bonds, asymmetry of bond arrangement due to lone pair of electrons.</td></tr>
<tr><td>3(a)</td><td colspan="4">Going across the third row / from left to right, the melting points decrease.</td><td>Trend correct.</td><td></td><td></td></tr>
<tr><td rowspan="4">3(b)</td><td>NaCl</td><td colspan="3">ionic</td><td rowspan="4">Any 3 bonding types correct.</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>$MgCl_2$</td><td colspan="3">ionic</td></tr>
<tr><td>$SiCl_4$</td><td colspan="3">van der Waals / intermolecular</td></tr>
<tr><td>SCl_2</td><td colspan="3">van der Waals / intermolecular / permanent dipole / dipole-dipole</td></tr>
<tr><td rowspan="5">4(a)
4(b)
4(c)</td><td></td><td>(a)</td><td>(b)</td><td>(c)</td><td rowspan="2">Any 3 of (a), ie type of particle, correct.</td><td rowspan="2"></td><td rowspan="5"></td></tr>
<tr><td>S_8</td><td>molecules</td><td>van der Waals / inter-molecular</td><td>weak</td></tr>
<tr><td>Cu</td><td>atoms / ions</td><td>metallic bond</td><td>strong</td><td rowspan="3">Any 3 of (b), ie attractive force, correct.</td><td rowspan="3">Any 3 rows correct.</td></tr>
<tr><td>MgO</td><td>ions</td><td>ionic bond</td><td>strong</td></tr>
<tr><td>C</td><td>atoms</td><td>covalent bond</td><td>strong</td></tr>
</table>

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
5	Solid $MgCl_2$ is a lattice of **Mg^{2+} and Cl^- ions** held together by strong **ionic bonds**. These forces hold the ions in a **fixed position**. As there is **no charge able to move**, the solid will not conduct electricity. When melted the **Mg^{2+} and Cl^- ions** become **free moving**, and this free moving charge allows the liquid to conduct electricity.	The type of particle **OR** force existing between the particles is correctly identified for any **2** substances.	Properties of any **2** substances are explained but may lack some detail.	All solid properties for all **3** substances are correctly and clearly explained with sufficient detail. *[Liquid $MgCl_2$ properties are not required for Excellence,* but solid $MgCl_2$ properties must be explained.]
	Cl_2 consists of **Cl_2 molecules**. The force existing between the molecules is a **weak van der Waals force**. As **little energy** is needed to overcome this weak force the melting point is very low.			
	Zinc atoms are held together in a 3–D **lattice** by **metallic bonding** in which valence electrons are attracted to the nuclei of neighbouring atoms. As this is a **non–directional** force, layers of atoms can slide over each other without breaking the metallic bond and disrupting the structure and breaking the metal.			
6	**CO_2** Exists as **molecules**. Weak **van der Waals** forces exist between the molecules. As all valence electrons are involved in forming covalent bonds there are **no free moving charges** and so no electrical conduction. As the van **der Waals forces** between **molecules** are **weak** these are easily overcome hence **little energy** is required to **separate** the molecules [therefore has a low MP/sublimes at -78°C]. Also since the **weak van der Waals** forces allow the **molecules** to be **easily separated** this makes it brittle / (easy to break the solid).	The **type** of **particle** AND **force** existing between the particles is correctly identified.	Any **2** properties are explained but may lack some detail. [Must also have correctly identified the type of particle and the force existing between the particles.]	Clearly explains all **3** properties stated. [Must also have correctly identified the type of particle and the force existing between the particles.]

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
	SiO_2 Exists as **3–D covalent network**. Strong covalent bonds hold the Si and O **atoms** together in a 3–D arrangement. As all valence electrons are involved in forming covalent bonds there are **no free moving charges** and so no electrical conduction. As the **covalent bonds** between atoms are **strong** they require a **lot of energy** to overcome and separate atoms so the melting point is very high. Also since the **strong covalent bonds** hold the atoms **firmly in the 3–D** structure, the solid is very hard.	The **type** of **particle** AND **force** existing between the particles is correctly identified.	Any **2** properties are explained but may lack some detail. [Must also have correctly identified the type of particle and the force existing between the particles.]	Clearly explains all **3** properties stated. [Must also have correctly identified the type of particle and the force existing between the particles.]

Judgement Statement

Chemistry: Describe the nature of structure and bonding in different substances (90308)

Achievement

Total of **SIX** opportunities answered at Achievement (or higher)

6 × A

Merit

Total of SEVEN opportunities answered with **FIVE** at Merit level and TWO at Achievement level.

5 × M + 2 × A

Excellence

Total of SEVEN opportunities answered with **THREE** at Excellence level and TWO at Merit level and TWO at Achievement level.

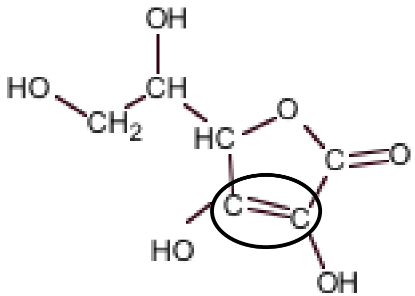
3 × E + 2 × M + 2 × A

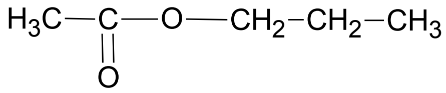
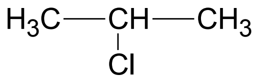
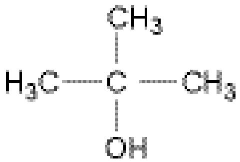
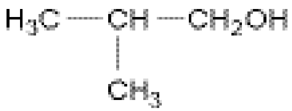
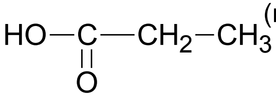
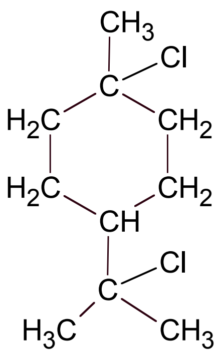
Assessment Schedule

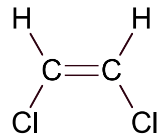
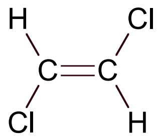
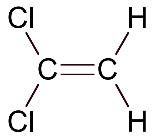
Chemistry: 2.5 Describe the structural formulae and reactions of compounds containing selected organic functional groups (90309)

Evidence Statement

Formulae as per NCEA Level 2 Assessment Specifications sheet

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a) 1(b) 1(c) 1(d)	butan–2–ol / 2-butanol / 2-hydroxybutane 3–chlorobutanoic acid $H_3C-O-C(=O)-CH_2-CH_3$ $H_2C=C(Cl)-CH_2-CH_2Cl$	3 correct.	All correct, showing understanding of use of numbers to indicate position of groups in organic molecules.	
2(a)		C = C circled.		
2(b)	A primary B secondary	A and B classified correctly.		
3(a) 3(b)	$HC(CH_3)=CH_2$ $HC(Cl)=CH_2$	C = C recognised as a requirement in both monomers.	Monomer molecules both correct.	

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
4(a)(i) 4(a)(ii) 4(a)(iii) 4(a)(iv)	(i)  (ii)  **OR** $H_3C—CH_2—CH_2Cl$ (iii)  **OR**  **OR** $CH_3C(OH)(CH_3)_2$ (note use of brackets on OH) (iv)  **OR** CH_3CH_2CHO		Products of 3 of the reactions identified correctly.	
4(b)	(i) ester / (ii) halo / halide / chloro chloride (iii) alcohol / akanol hydroxy / hydroxyl (iv) carboxylic / alkanoic: acid carboxyl F/O aldehyde / alkanal F/O Note: NO FOLLOW ON from **errors** in 4(a)	3 functional groups identified correctly.		
5		Addition of HCl at one double bond (major or minor product)	Structural formula of product correct.	

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
6(a)	 *cis*–1,2–dichloroethene  *trans*–1,2–dichloroethene	Structural formulae of the 2 isomers correct. OR One isomer drawn and named correctly.	Isomers drawn and named correctly.	
6(b)	The other structural isomer is  • double bond/C=C: does not <u>rotate</u> / groups in fixed positions • require 2 different groups/atoms on each (double bonded) C / (referring to (b) 2 Cls (or Hs) on same (double bonded) C • molecules in (a) meet these criteria • molecules in (b) do not meet these criteria	Structure correct. OR Non-rotation of double bond	Structure correct. Explanation refers to C = C or "double bond" in some appropriate way. (See evidence)	Structure correct. Clear explanation relating to *cis–trans* isomers for (a) and (b) structures Must mention non-rotation of double bond.

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
7	In (i) Other suitable tests may exist. (But not flame test or $KmnO_4$ or water solubility for 7(a)) In (ii) must mention observation, for the same test, for both chemicals. If there's a colour change, candidate must mention both colours	Suitable test and correct expected observation for both molecules of **one** of the pairs.	Suitable tests and correct observations and how these are used to distinguish between the molecules for **each** pair. **OR** 7(a) OR 7(b) ALL correct	Suitable tests and correct observations and how these are used to distinguish between the molecules for each pair. Reasons for why each test is a suitable one to use, eg reference to either ability of alkene to undergo addition reaction or alcohol to be oxidised in (a)
7(a)	Note: but-2-ene BP = 4°C butan-1-ol BP = 118°C (i) Add bromine water to a sample of each. (ii) Butan–1–ol: Orange colour of bromine remains – But–2–ene: Orange colour of bromine disappears /goes colourless OR bromine decolorises : (iii) An addition reaction occurs OR occurs due to C = C / unsaturated bond : (in alkene) **OR** (i) Add $Cr_2O_7^{2-}$ / H^+. (ii) Butan – ol: orange colour of $Cr_2O_7^{2-}$ goes green But-2-ene: orange colour of $Cr_2O_7^{2-}$ remains (iii) The (primary) alcohol can be oxidised with acidified dichromate / Alkene cannot be oxidised by acid dichromate. **OR** (i) Observe state (ii) Butan-1-ol is a liquid Butene is a gas (iii) Butan-1-ol has stronger attractive forces between molecules or equivalent statement.			
7(b)	Note: butanoic acid BP = 163°C methyl butanoate BP = 103°C (i) Add (sodium) carbonate / Mg or more reactive metal (ii) Butanoic acid: Fizzing occurs Methyl butanoate: No change (iii) H^+ from the –COOH group / acid: reacts with carbonate to form CO_2(g) / metal to form H_2 gas OR Neutralisation (of carbonate) **OR** (i) Add blue litmus / Universal Indicator (ii) Butanoic acid: litmus goes blue to red / U.I. goes green to red Methyl butanoate.: Litmus remains blue. / U.I.remains green			

Question	Evidence		Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
7(b)	(iii) Butanoic acid acts as acid OR Butanoic acid / Carboxylic acid is proton donor (If U.I. must add: methyl butanoate is neutral) **OR** (i) Add to water (ii) Butanoic acid: miscible Methyl butanoate: layered (iii) Water dissolves polar substances – Butanoic acid is polar / methyl butanoate is non-polar **OR** (i) test conductivity (ii) Butanoic acid: conducts, Methyl butanoate: doesn't (iii) Butanoic Acid produces ions in solution **OR** (i) smell (ii) Butanoic acid smells foul / of rancid butter and Methyl Butanoate does not **OR** Butanoic Acid does not smell and Methyl butanoate smells sweet / of pineapple / fruity				
8	**A** $H_2C{=}CH{-}CH_3$	propene prop-1-ene 1-propene	A name or formula correct in 3 of 5 rows.	3 molecules identified and named correctly.	Compounds A to E all identified correctly – names and structures.
	B $H_2C(OH){-}CH_2{-}CH_3$ (OH on first C)	propan–1–ol 1-propanol			
	C $H_3C{-}CH(OH){-}CH_3$ (HO on middle C)	propan–2–ol 2-propanol			
	D $HO{-}C({=}O){-}CH_2{-}CH_3$	propanoic acid			
	E $H_3C{-}CH_2{-}CH_2{-}O{-}C({=}O){-}CH_2{-}CH_3$	propyl propanoate			

Judgement Statement

Chemistry: Describe the structural formulae and reactions of compounds containing selected organic functional groups (90309)

Achievement

Total of **SIX** opportunities answered at Achievement (or higher)

$6 \times A$

Merit

Total of EIGHT opportunities answered with **FIVE** at Merit level and THREE at Achievement level.

$5 \times M + 3 \times A$

Excellence

Total of NINE opportunities answered with **TWO** at Excellence level and FOUR at Merit level and THREE at Achievement level.

$2 \times E + 4 \times M + 3 \times A$

Assessment Schedule

Chemistry: Describe principles of chemical reactivity (90310)

Evidence Statement

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a)	H_2CO_3 / HCO_3^- H_3O^+ / H_2O HCO_3^- / CO_3^{2-}	Two pairs correctly identified.		
1(b)	Equation 2 HCO_3^- is donating a proton / H^+	Equation correctly identified and reason given.		
2(a)	Exothermic A negative enthalpy change	Answer and reason correct.		
2(b)	$6.12 \times 5500 = 33\ 660$ kJ	Correct value.		
2(c)	$n(H_2) = 33\ 660/286 = 118$ mol (117.7) $m(H_2) = 117.7 \times 2 = 235$ g	One step of calculation correct.	Correct answer.	Correct answer, including correct unit and 3 s.f.
3(a)	$H_3O^+ + Cl^-$ $H_3O^+ + CH_3CH_2COO^-$	H_3O^+ identified as product in both equations.	Both equations correct.	
3(b)	Propanoic acid is a weak acid which only partially dissociates in water. Therefore, it will have a relatively low concentration of H_3O^+, resulting in a higher pH, and low concentration of ions overall, resulting in a low conductivity. Hydrochloric acid is a strong acid that fully dissociates in water. Therefore, it will have a high concentration of H_3O^+ and a lower pH, and a high concentration of ions overall, resulting in a high conductivity.	Identifies propanoic acid as a weak acid / partially dissociates and hydrochloric acid as a strong acid / fully dissociates **OR** Explains the term weak or strong with reference to the appropriate acid.	Links the strength / degree of dissociation of both acids to concentration of H_3O^+ and therefore pH **OR** Links the strength / degree of dissociation of both acids to the total concentration of ions in the solution and therefore conductivity.	Explains clearly both conductivity **AND** pH differences for both acids, with reference to the concentrations of species in solution. Explanation includes reference to the strength / degree of dissociation of each acid.

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
4(a) (i)	$\frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^-]}$	Answer correct including square brackets.		
4(a) (ii)	Colour lightens / disappears / goes paler / more orange. Removal of Fe^{3+} causes equilibrium position to shift towards the reactants in order to minimise the change, by replacing some of the Fe^{3+} that has been removed. The new equilibrium mixture will therefore have less $FeSCN^{2+}$ and will be lighter in colour.	Observation is correct.	Limited explanation given. Eg equilibrium goes left stated or implied	Full explanation given including equilibrium shift and lower concentration of $FeSCN^{2+}$ at new equilibrium.
4(b)(i)	$\frac{[NH_3]^2}{[N_2]\,[H_2]^3}$	Answer correct including square brackets. (subscripts not required)		
4(b)(ii)	Increased pressure of the system causes a shift to the right in order to decrease the pressure by forming fewer moles of gas. Therefore, the amount of NH_3 increases.	Increases	Limited explanation of change in NH_3. (Eg: links shift to the right to increasing pressure within the system).	Full explanation including direction of shift and reason for the change in the amount / moles/particles of NH_3 gas.
4(b)(iii)	As the temperature is increased the amount of NH_3 produced decreases, indicating a shift to the reactants. As increasing temperature causes equilibria to shift in the endothermic direction, the forward direction (the reaction producing NH_3) must be exothermic.	Exothermic. (Supported by some limited reasoning.)	Recognises as temperature increases NH_3 decreases **OR** states increasing temperature favours endothermic reactions.	Recognises as temperature increases NH_3 decreases **AND** states increasing temperature favours endothermic reactions **AND** links to exothermic forward reaction.
5(a)	Decrease / less time or similar / faster rate	Answer correct.		
5(b)	An increase in temperature means the particles have more kinetic energy. An increased number of collisions of particles, in a given time, will now reach the activation energy required for the reaction. Also there will be more collisions / time. Therefore, the frequency of successful collisions will increase. Thus the reaction rate is increased so the time required for reaction is decreased.	Recognises particles have more kinetic energy / move faster **OR** Particles collide more (with no reference to time).	Explanation limited to frequency of collisions. **OR** Effectiveness of collisions	Full explanation including reference to collision frequency **AND** Full explanation of collision effectiveness related to sufficient energy / activation energy.

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
6(a)	$> 1x\ 10^{-7}$ $< 1x\ 10^{-7}$ HNO_3 H_3O^+ OH^- NaOH OH^- H_3O^+ NH_4Cl H_3O^+ OH^-	OH^- and H_3O^+ correctly placed for two solutions.	OH^- and H_3O^+ correctly placed for all solutions.	
6(b)	pH = –log 0.035 = 1.46	Answer correct. (allow 2sf = 1.5, 4sf = 1.456)		
6(c)	$[H_3O^+]$ = inv log (-9.20) $= 6.31 \times 10^{-10}$ mol L^{-1} $[OH^-] = 1 \times 10^{-14} / 6.31 \text{ x } 10^{-10}$ $= 1.58 \times 10^{-5}$ mol L^{-1} **OR** pOH = 14 – 9.20 = 4.80 $[OH^-]$ = inv log (– 4.80) $= 1.58 \times 10^{-5}$ mol L^{-1}	One step of the calculation correct.	Correct answer. May have no or incorrect unit, poor rounding or wrong s.f.	Correct answer, including correct unit and 3 s.f.

Judgement Statement

Chemistry: Describe principles of chemical reactivity (90310)

Achievement
Total of **TEN** opportunities answered at Achievement (or higher)

$10 \times A$

Merit

Total of TEN opportunities answered with **FIVE** at Merit level and FIVE at Achievement level.

$5 \times M + 5 \times A$

Excellence

Total of TEN opportunities answered with **FOUR** at Excellence level and THREE at Merit level and THREE at Achievement level.

$4 \times E + 3 \times M + 3 \times A$

Assessment Schedule

Chemistry: Describe oxidation–reduction reactions (90311)

Evidence Statement

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a)	(i) 2 (ii) –1 (iii) 0 (iv) 4 (v) 2	Any three correct		
1(b)(i) (ii)	H_2O_2 has oxidised Br^- ions to Br_2 (orange colour). H_2O_2 is reduced to H_2O and both are colourless.	Br^- : oxidised : H_2O_2 / O / O^{-1} : reduced / Br_2 : orange	Br^- : oxidised : H_2O_2 / O /O^{-1}: reduced **and** Br_2 : orange	Oxidation of Br^- to Br_2 : orange colour : water
1(b)(iii)	The Fe^{2+}causes the pale green solution. Cl_2 oxidises Fe^{2+} ions to form Fe^{3+} ions. Cl_2 is reduced to colourless Cl^- ions. The final orange colour is due to the Fe^{3+} ions formed.	Fe $^{3+}$: orange	Oxidation of Fe^{2+}: Fe^{3+} : Orange / $Fe^{+2} \rightarrow Fe^{+3} + e^-$	Fe+^{2} oxidised : Cl_2 reduced **AND** Fe^{+2}/ Cl_2 : pale green : Fe^{+3}: orange : Cl^- produced.
2(a)	Oxidation number of S in SO_2 has increased from 4 to 6, therefore it has been oxidised and must be the reductant.	SO_2 / S if correctly justified	Oxidation number of S : increases from 4 to 6 : oxidised therefore is the reductant **OR** Oxidation number of Cr : decreased from 6 to 3 : reduced	
2(b) (c)	Oxidation: $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$ Reduction: $14H^+ + 6e^- + Cr_2O_7^{2-} \rightarrow$ $2Cr^{3+} + 7H_2O$ Balanced : $Cr_2O_7^{2-} + 3SO_2 + 2H^{+2} \rightarrow$ $3SO_4^{2-} + 2Cr^{3+} + H_2O$	One half-equation correctly balanced.	Both half-equations correctly balanced and correctly identified. **OR** Half equations and overall equation correct, but half equations are not correctly identified.	Overall equation is correctly balanced and half equations are correctly identified as oxidation and reduction.
2(d)	Colourless sulfur dioxide is bubbled into the orange $Cr_2O_7^{2-}$ solution. A colour change form orange to green is observed. The $Cr_2O_7^{2-}$ ions are reduced to green Cr^{3+} ions. Colourless SO_4^{2-} ions are also formed in solution.	Identified orange to green colour change. **OR** One Cr species identified with its correct colour.	Orange $Cr_2O_7^{2-}$: green Cr^{3+} (chromium (III) / chromic)	Orange $Cr_2O_7^{2-}$: green Cr^{3+} **AND** SO_2 : SO_4^{2-} : Colourless

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
3(a)	(i) −1 (ii) +5 or 5	Both correct		
3(b)	Oxidant: IO_3^- Reductant: I^-	Both correct		
3(c) (d)	$2I^- \rightarrow I_2 + 2e^-$ $2IO_3^- + 12H^+ + 10e^- \rightarrow I_2 + 6H_2O$ $5I^- + IO_3^- + 6H^{+2} \rightarrow 3I_2 + 3H_2O$	One half equation is correctly balanced.	Both half-equations correct.	Correctly balanced equation. (or correct final equation × 2)
4(a)	Left-hand half cell: Anode Right-hand half cell: Cathode	Both correct		
4(b)	$2Cl^- \rightarrow Cl_2 + 2e^-$	Equation correct.		
4(c)	Gas A Cl^- ions oxidised at the anode (positive electrode) to produce Cl_2 H_2O reduced at the cathode (negative) charged electrode to produce H_2	Gas A Chlorine identified correctly with justification (Cl^- moves to positive electrode).	oxidation : anode / positive electrode / half equation **OR** reduction : cathode / negative electrode / half equation.	Cl_2 : oxidation : anode / positive electrode **AND** H_2 : reduction : cathode / negative electrode.
5	Ag^+ ions in the electrolyte solution migrate to the negatively charged spoon (cathode). Ag^+ ions gain electrons and are reduced to Ag metal and are plated onto the spoon. $Ag^+ + e^- \rightarrow Ag$ At the anode (positive electrode) Ag atoms of silver metal are oxidised to Ag^+ ions, which go into the solution. Hence the Ag electrode decreases in size. $Ag \rightarrow Ag^+ + e^-$	Ag^+ : reduced : Ag spoon **OR** Ag : oxidised : anode / silver metal electrode **OR** spoon is negative electrode : Ag^+ migrate to this.	Ag^+ : reduced : Ag spoon **AND** Ag : oxidised : anode / silver metal electrode **AND** spoon is negative electrode : Ag^+ migrate to this.	All Criteria for Merit **AND** correct half equations **AND** Ag electrode is required to replace Ag^+ ions in solution.

Judgement Statement

Chemistry: Describe oxidation−reduction reactions (90311)

Achievement

Total of **EIGHT** opportunities answered at Achievement level (or higher)

8 × A

Merit

Total of EIGHT opportunities answered with **FOUR** at Merit level and FOUR at Achievement level.

4 × M + 4 × A

Excellence

Total of EIGHT opportunities answered with **FOUR** at Excellence level and FOUR at Achievement level.

4 × E + 4 × A